

## Self-Injurious Behavior: A Review of the Behavior and Biology of Self-Mutilation

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***Objective:** The authors describe the clinical characteristics of self-injurious behavior, giving special emphasis to self-injurious behavior occurring among individuals with character disorders. **Data Collection:** They review data suggesting the involvement of serotonergic, dopaminergic, and opiate neurotransmitter systems in the expression of self-injurious behavior. **Findings:** Self-injurious behavior occurs among mentally retarded individuals, psychotic patients, prison populations, and individuals with severe character disorders. Although theoretical psychological models of self-injurious behavior are helpful in understanding the patient's experience of self-injury, no generally useful therapeutic approach has yet evolved from these models. Data derived from animal models and treatment studies suggest the involvement of opiate and dopaminergic mechanisms in self-injury among the mentally retarded. Serotonergic influences on self-injurious behavior may be present in varying forms of this behavior. The scientific literature on the benefits of pharmacological agents for mentally retarded individuals is beset with a number of problems. Support is emerging, however, for the use of lithium and carbamazepine with self-injuring mentally retarded patients, and some behavioral interventions appear to be successful for mentally retarded individuals. Self-injuring patients with borderline personality disorder may benefit from milieu treatment. **Conclusions:** Although no form of treatment has yet been demonstrated to be of general benefit, the literature suggests that therapeutic trials with dopamine antagonists, serotonin reuptake inhibitors, and opiate antagonists may be of value.*

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Self-injurious behavior is a dramatic but poorly studied phenomenon. Successful treatments of this behavior remain elusive. Among the mentally retarded, behavioral approaches have achieved some successes and occasional benefits have been described with a variety of psychotropic medications. Among other categories of self-injuring patients, such as individuals with severe character disorders, however, successful pharmacological, psychological, or psychodynamic treatment of this behavior appears to be uncommon.

In this paper we describe the clinical characteristics of self-injurious behavior. Special emphasis is given in this review to self-injurious behavior occurring among

individuals with character disorders. We also review data that variously suggest the involvement of serotonergic, dopaminergic, and opiate neurotransmitter systems in the expression of this behavior. Possible models for underlying biological mechanisms may now be considered on the basis of animal models, response to treatment, and studies of neurotransmitter function in affected individuals.

We propose that self-injurious behavior be defined as the commission of deliberate harm to one's own body. The injury is done to oneself, without the aid of another person, and the injury is severe enough for tissue damage (such as scarring) to result. Acts that are committed with conscious suicidal intent or are associated with sexual arousal are excluded. Common forms of self-injurious behavior include cutting and burning the skin, banging the head and limbs, picking at wounds, and chewing fingers.

### BEHAVIORAL PATTERNS

Self-injurious behavior may be categorized by the type of patient and the clinical context in which it

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occurs: 1) mentally retarded individuals, 2) psychotic patients, 3) prison populations, and 4) individuals with character disorders (primarily borderline personality disorder).

### *Mentally Retarded Individuals*

Self-injurious behavior is a serious problem in facilities that care for the mentally retarded. Estimates of the incidence of self-injurious behavior among such patients range from 3.5% to 40% (1–3). Outward-directed aggression is also common among the mentally retarded and frequently coexists with self-injurious behavior. Although present among individuals with mental retardation of many etiologies, the most dramatic and relentless form of self-injurious behavior occurs among children with Lesch-Nyhan syndrome.

Lesch-Nyhan syndrome (4) is an X-linked enzyme deficiency disorder characterized by mental retardation, spasticity, choreoathetosis, and, often, almost unremitting self-injury. Compulsive and stereotypic self-injury, particularly finger-chewing, often requires that victims of the syndrome be maintained in almost constant physical restraints. Even in restraints, patients frequently manage to injure themselves by chewing their lips and oral tissues. Self-injurious behavior is also present among patients with another rare congenital disorder of retarded development, the Cornelia de Lange syndrome (5, 6), as well as among individuals with mental retardation of other etiologies, whose stereotypic self-injuring behavior is similar to that of children with Lesch-Nyhan syndrome and de Lange syndrome but less severe and less refractory to behavioral management. Self-injurious behavior among mentally retarded patients without Lesch-Nyhan or de Lange syndromes usually appears only after admission to a chronic care facility.

### *Psychotic Patients*

Unlike the repetitive, stereotypic self-injurious behavior of mentally retarded patients, self-injuring acts among psychotic patients tend to be sporadic. It is among these patients that one hears of the dramatic and exotic examples of self-harm (7): autocastration, self-enucleation, autoamputation of digits and limbs, autocannibalism, and even autosurgery.

Self-injurious behavior among psychotic patients often occurs in response to command hallucinations or delusions (frequently religious in nature). Themes of punishment for guilt and sexual transgression are common (7). In one study of male patients who injured their own genitals (8), 87% were found to be psychotic at the time of the incident. Kalin (9) reported a dramatic case of a 22-year-old man who attempted to denervate his adrenal glands. The patient wanted to eliminate the production of circulating catecholamines, which he held responsible for unwanted aggressive and sexual impulses. Although his belief was

based on delusional reasoning, the patient believed his behavior to be rational.

### *Prison Populations*

There are many reports of self-injury among prisoners (10–20). Based on reports from three men's prisons, Toch (19) estimated a rate of 2.2%–7.7%.

Self-injurious behavior in prisons is difficult to assess because of poor documentation, drug use, and undiagnosed psychiatric disorders. Many self-injurious events among prisoners are suspected of being intentionally manipulative, designed to force transfer to a less restrictive facility. Isolation within prison may precipitate self-injurious behavior (12, 16, 17, 20). Virkkunen (16) compared 40 self-injuring prisoners with 40 prisoners who did not injure themselves. All (injurers and noninjurers) fulfilled criteria for antisocial personality disorder. Among the subjects who injured themselves there was a significantly higher rate of fighting, outbursts of rage, drug abuse, and anxiety.

Epidemics of self-injury have been reported in correctional institutions for teenage offenders. Ross and McKay (21) described their work with female adolescents in such a facility. In this setting, the carving of words, letters, or insignia on themselves appeared to carry consciously intended messages of group identification and assertion and may have been void of the impulsivity inherent to other forms of self-injurious behavior. However, it bears a similarity to self-injurious behavior in adult penal institutions in its seeming contagion (10), the shared forensic nature of the populations, and the facilitative effect of incarceration.

### *Patients With Character Disorders*

Other than the notable presence of personality disorders, patients with character disorders who injure themselves do not share any single obvious trait such as incarceration, psychosis, or mental retardation.

Gardner and Cowdry (22) described the range of self-injurious behaviors they encountered in a study of self-destructive patients with borderline personality disorder. These included cuts on the wrist and the body, cigarette burns, scratching oneself with fingernails, carving words on the skin, arm- and head-banging, sandpapering the face, dripping acid on the hands, and trying to break an arm with a hammer. According to *DSM-III-R*, impulsive, self-injurious behavior—among nonpsychotic, intellectually normal individuals—may be diagnosed as either impulse control disorder not otherwise specified or as a symptom of borderline personality disorder. The anecdotal perception of an association between self-injurious behavior and borderline personality disorder developed over the past two decades.

In the 1960s, several authors (23, 24) described a category of patient called the “wrist-cutter” or “wrist-slasher.” The separate grouping of these patients was largely dismissed after two studies (25, 26) demon-

strated that wrist cutting did not specify a group that could be distinguished from other suicide attempters. However, the earlier studies may have been the first to suggest the presence of a group of patients, most of whom are young and female, with a high rate of self-injurious acts associated with poor tolerance of anxiety and anger.

Pattison and Kahan (27) reviewed 56 published case reports of self-injurious behavior. After excluding subjects with apparently lethal intent as well as psychotic and retarded individuals, an identifiable pattern discriminated a large portion of the reported patients. These traits include low lethality of acts, multiple self-injurious acts, and typical onset in adolescence. Pattison and Kahan did not conclude that these patients suffered from specific personality disorders and chose to refer to the "deliberate self-harm syndrome." Other authors, however, have more recently replaced the phrase "wrist-cutter" with a new designation, the "borderline self-mutilator" (28).

Self-injurious behavior by individuals in this category often bears several consistent features. Leibenluft et al. (28) described five stages of the self-injuring act: "(1) the precipitating event (such as loss of a significant relationship), (2) escalation of the dysphoria, (3) attempts to forestall the self-injury, (4) self-mutilation, and (5) the aftermath (for example, relief from tension)."

The following, quoted by Gardner and Cowdry in 1985 (22), is one patient's description: "The impulse . . . overcame the strength of my resistance not to . . . As I started to cut, the physical pain and blood became a welcome distraction. As I cut deeper, . . . my mind began to feel relieved of the torment, my body eased of the tension, and I began to feel comforted." The development of escalating anxiety has been emphasized in the descriptions by both observers and patients (29).

The experience of pain varies among those who injure themselves. Absolute or relative analgesia for the event is commonly described (22). Leibenluft et al. (28) commented that in their experience about half of the patients who injure themselves have some degree of analgesia. Some patients report that the experience of pain is accompanied by relief. Patients' explanations for this expression of relief vary; some report feeling reassured by the capacity to feel physical sensation, assuring them they are still alive. For others it is a distraction from other dysphoric feelings, such as unbearable anger, and for others it produces a feeling of empowerment when overwhelmed by feelings of helplessness.

During the act of self-injury, many patients describe experiences of derealization and depersonalization. Such dissociated states are invoked by some psychoanalysts to explain the apparent anesthesia that allows some patients not to experience pain (30).

In 1978, Yaryura-Tobias and Neziroglu (31) suggested an association between eating disorders and self-injury. Favazza et al. (32) also postulated an asso-

ciation between self-injurious behavior and eating disorders on the basis of questionnaires completed by 254 subjects who said that they had injured themselves. Walsh (personal communication) reported that 27 (33%) of 81 randomly selected patients with bulimia who answered a questionnaire admitted to a history of self-injurious behavior. Jacobs and Issacs (33) compared 40 patients with anorexia with 20 normal control subjects and found that 35% of the patients with anorexia but none of the control subjects had histories of self-injurious behavior. Conclusions based on these studies are limited either by nonrandom subject selection, overinclusive criteria for self-injurious behavior, and/or dependence on the response to a single questionnaire item to identify a history of self-injurious behavior. However, in an unpublished follow-up study of 44 subjects who had been hospitalized for treatment of bulimia, Fallon and Winchel found that 39% had a history of self-injurious behavior. Data in this study were obtained by direct interview and by use of an instrument designed to assess self-injurious behavior. Just as there seems to be a high rate of histories of eating disorders among samples of individuals selected for the presence of self-injury (32), there also appears to be a high rate of self-injurious behavior among patients selected for the presence of eating disorders (33, 34).

Rates of self-injurious behavior may vary within subgroups of patients with eating disorders. Garfinkel et al. (34) observed that a history of self-injurious behavior appears to be more common among bulimic than anorectic patients. Mitchell et al. (35) found that 41% of a group of patients with bulimia who engaged in laxative abuse had a history of self-injurious behavior, compared with 26% of patients with bulimia who did not abuse laxatives. Suicide attempts were reported in a separate category in this study. Although most of these studies have methodological problems, several of them suggest that the coincidence of histories of self-injurious behavior with eating disorders ranges from 25% to 40%. The prevalence of this often hidden symptom among bulimic and anorectic patients may be underappreciated in clinical settings.

## PSYCHODYNAMIC PERSPECTIVES

The psychoanalytic literature offers few theoretical treatments of self-injurious behavior. The deep human aversion to pain, however, has prompted several writers to consider two problems: what are the sources of the motivation for self-injury and by what psychological means can individuals inflict direct harm on their own bodies?

Attempting to understand individuals' motivation to wound themselves, Kafka (36) appealed to Winnicott's concept of transitional objects (37). Describing the reaction of a self-injuring patient, Kafka noted the relief experienced by the patient as she felt her own "warm" blood flowing over her skin. Kafka suggested that the

blood was linked to the patient's internalized representation of her mother, which the patient sought to externalize into a soothing transitional object in times of crisis. Thus, motivation to injure oneself springs from the need to reduce intolerable feelings of tension.

Kafka suggested that it is necessary for a patient transiently to experience his or her own skin as a "not-me" object, so that the automutilation can be carried out. Pao (30) considered this problem more extensively. He hypothesized that on beginning the action of cutting, the individual enters an altered ego state. Pao compared this condition to the experience of depersonalization and derealization—the dissociated state appears to engulf some patients during the act of self-injury. The temporary suspension of ego direction allows the individual to be so directly self-damaging.

Although such considerations attempt to understand why and how individuals wound themselves, we are still left with the problem of why such an extreme measure is employed to deal with dysphoric feelings. Because of the propensity of self-injuring patients to use primitive defense mechanisms such as denial, splitting, and projective identification, psychodynamic theoreticians have tended to link such behavior to preoedipal developmental pathology. Graff and Mallin (23) have suggested that because these patients share developmental injuries in "preverbal stages," relief from tension is sought through "physical, preverbal messages." Noting frequent histories of maternal deprivation, they speculated that "the patient has protected herself against maternal rejection by introjecting her mother, allowing her to both hold onto the lost object and to deal with it by destroying that part of it within herself . . . . The pleasurable feeling derived from slashing is therefore both the joy of punishing the depriver and a stimulatory act of self-manipulation to make up for the lack of outside stimulation."

This view of the self-injuring patient is consistent with the understanding of Grunebaum and Klerman (24). Noting the frequent use of defensive "splitting" by these patients in their relations with hospital staff, these authors stated that they "incline toward the view that the wrist-slashing patient belongs to a syndrome in the borderline group." Consequently, they recommended an inpatient treatment strategy based on ego psychology with a strong emphasis on understanding the "interpersonal dynamics of the ward social structure."

Podvoll (38), in his discussion of patients who injure themselves, also emphasized the symptom's use in relation to the community. In part, he suggested, the patient is seeking to protect himself or herself and external objects from omnivorous and engulfing demands on others. "There is a flight from deeply dependent, even symbiotic wishes toward a primitive love object to a reliance on the autoerotic use of one's own body. The symptom forestalls the more regressive strivings made upon the therapist and staff." By redirecting aggression toward oneself, "the rage and explosiveness appear to find a secure home on a fixed and

seemingly indestructible object . . . and in this way the patient manages to preserve intact his split off and idealized object."

Stone (39) noted that many self-mutilating patients with borderline personality disorder have experienced sadistic sexual abuse from an older person early in life. Subsequent sexual desire, Stone suggested, is associated with extreme guilt; the self-mutilation relieves the tension arising out of guilt—the mutilation punishes not only the patient but, in effigy, the original perpetrator or perpetrators of the abuse.

Kernberg (40) recommended caution in the attribution of specific meaning to the symptom of self-injury. He questioned the pragmatic value of "metapsychological theorizing" about the meaning of self-injurious acts because of its remoteness from the patient's internal experience. He refrained from imparting any special significance to this particular symptom and cautioned the therapist against early "genetic interpretations" of the symptom. It should be noted that Kernberg did not imply that specific psychological meaning is not attributable to these acts. However, such attribution may have no practical value in psychological treatment of severe character disturbance and, indeed, may be counterproductive in early stages of therapy.

In summary, theoretical psychodynamic discussions of self-injuring individuals have been sparse. In general, such formulations have viewed these patients as having significant defects in early stages of ego development. Such deficits explain the capacity for entering dissociated states and the preponderance of other primitive defenses. The havoc they wreak on their bodies may be seen as directed toward internalized representations of others or as attempts to undo guilt. Episodes of self-injury may often be temporally linked to crises in relationships with significant others. Ego psychology provides a useful framework both for understanding these individuals and for constructing a psychodynamically based psychotherapy. However, despite the "meaningfulness" that dynamic views may contribute to attempts to understand and empathize with these individuals, no generally applicable therapeutic strategy has evolved from this framework.

## BIOLOGICAL ASPECTS

### *The Opiate System*

Painful stimulation has been demonstrated to result in increased release of endorphins (41). The presumed positive reinforcement associated with the release of endogenous opiates has been invoked as a possible explanation for repetitive behaviors that may result in opiate release. It has been suggested that the opiate system of some individuals may be altered in such a way that increased release of endogenous opiates is necessary to maintain adequate opiateergic "tone." This model has also been invoked as a potential expla-

nation of self-injurious behavior. Opiate antagonists have been administered to patients with self-injurious behavior in an effort to diminish the theorized reward that may result from stimulation of opiate receptors. Of 25 reported patients, nine were treated with naloxone and 15 with naltrexone (42–56). One patient received both agents. Twenty-one of the patients had mental retardation of varying etiologies, three had Tourette's syndrome, and one had major depression accompanied by neurotic excoriations. Treatment and experimental methods varied widely among these reports; therefore, no conclusion regarding efficacy of these agents may be drawn. However, improvement was reported for 17 of the 25 patients. A larger, double-blind, case-controlled study of longer duration is clearly indicated.

Another indication of dysregulation of opiate systems in self-injurious behavior may come from measures of "endogenous opiates." Coid et al. (57) measured plasma neuropeptide concentrations (met-enkephalin, N-lipotropin, and  $\beta$ -endorphin) in patients who had been admitted to the hospital for treatment of self-injurious and other impulsive behaviors. More severely affected patients had significantly higher plasma levels of met-enkephalin. The authors noted the limitations of plasma measurements of met-enkephalin and suggested that analysis of CSF concentrations may yield more useful information.

Episodic increase in opioid activity may explain the clinical observation in many patients who injure themselves that apparent insensitivity to pain (analgesia) may accompany "dissociation" (altered alertness). As yet, there is little support for a role of opiate dysfunction associated with self-injurious behavior, but the case reports of positive effects of opiate antagonists merit further exploration.

### *Dopaminergic Dysregulation*

Investigators have suggested that self-injurious behavior in patients with Lesch-Nyhan syndrome (5, 6, 58) and Tourette's syndrome (49, 59) may be related to dysregulation of dopaminergic activity and dopamine receptor supersensitivity. Lloyd et al. (60) have shown that CNS dopamine and its metabolites are markedly lower in patients with Lesch-Nyhan syndrome. Along with others (5, 6), Goldstein et al. (58) suggested that self-injurious behavior in Lesch-Nyhan syndrome may result from dopaminergic stimulation in a state of receptor supersensitivity.

Sokol et al. (61) reported on four patients with attention deficit disorder with hyperactivity in whom self-biting behavior was elicited by the administration of stimulants (dextroamphetamine and methylphenidate). In accord with the dopamine hypothesis of attention deficit disorder with hyperactivity, Sokol et al. speculated that these patients had dysregulation of dopamine function. They further speculated that the dopamine agonist activity of these stimulants in a supersensitive dopaminergic system resulted in self-bit-

ing, as was suggested regarding individuals with Lesch-Nyhan syndrome. However, although treatment of these patients with stimulants is known often to elicit dyskinesias and tics (also possibly linked to dopaminergic dysfunction), self-biting is not common.

Proponents of this model seek support in the observation that rats who have had chemical denervation of dopaminergic neurons with 6-hydroxydopamine exhibit self-biting behavior when administered dopamine agonists (such as L-dopa or apomorphine) (62). Goldstein et al. (63) replicated this finding. They also reported that treatment with both SCH 23390 (a selective  $D_1$  dopamine receptor antagonist) and fluphenazine (a mixed  $D_1$  and  $D_2$  antagonist) blocked the elicitation of self-injurious behavior with L-dopa.

Goldstein et al. (58, 64) further investigated this model by studying monkeys who had denervation of nigrostriatal dopamine neurons. Self-biting behavior emerged in this model as well. Again, treatment with SCH 23390 (0.3 mg/kg) and fluphenazine (1.5 mg/kg) blocked this effect. However, treatment with intramuscular sulpride (100 mg/kg), a  $D_2$  dopamine antagonist, failed to block the L-dopa-elicited emergence of self-injurious behavior. Goldstein et al. concluded that self-injurious behavior resulting from dopamine denervation and subsequent stimulation with dopamine agonists was mediated by  $D_1$  and/or combined  $D_1$  and  $D_2$  receptor pathways, but not by  $D_2$  alone. The specificity of this effect is put in doubt by the finding that rats with neonatal dopaminergic lesions also have exacerbations of self-injurious behavior when administered agonists of either the  $\gamma$ -aminobutyric acid (65) or adenosine neurotransmitter systems (unpublished 1988 paper of Breese et al.). In an interim report (unpublished 1988 paper), Gualtieri et al. found that fluphenazine, a predominantly  $D_1$  antagonist, reduced self-injurious behavior in 11 of 16 mentally retarded patients.

Gillman and Sandyk (49) and Sandyk and Bamford (66) noted that the benefits of opiate antagonist administration may also be viewed in terms of the inhibitory effects of opiates on behavior mediated by the dopaminergic system. These authors suggested that if opiate antagonists do decrease self-injurious behavior, it may represent an indirect effect on the dopamine system and does not necessarily implicate opiate dysfunction in underlying pathophysiology.

Although these speculations are of interest, it should be borne in mind that the presence of dopamine supersensitivity among patients with attention deficit disorder with hyperactivity and Lesch-Nyhan syndrome is unproven. It is interesting to note, however, that self-injurious behavior is also reported among individuals with Tourette's syndrome, another condition in which speculations of hypersensitive dopamine receptors have been proposed (67) and in which dopamine antagonists have been clinically useful.

In summary, there is little evidence as yet that opiate or dopaminergic mechanisms are involved in the pathophysiology of self-injurious behavior. In ad-

dition, the indirect evidence that the few animal and treatment studies available yield may be relevant to understanding only self-injurious behavior associated with patients with Lesch-Nyhan syndrome and other developmental disorders. In contrast, the serotonergic influences on self-injurious behavior may be present in varying forms of self-injurious behavior.

### *Serotonergic System*

In the light of animal data that have tied aggression to serotonergic depletion and the suggestion that self-injurious behavior represents a form of aggression, Mizuno and Yugari (68, 69) administered 1–8 mg/kg per day of 5-hydroxytryptophan, a precursor of serotonin, in an open trial to four self-injuring patients with Lesch-Nyhan syndrome. They reported a dramatic alleviation of self-injury in all four patients within 3 days of initiating medication. All patients resumed injuring themselves within 15 hours after drug treatment had stopped. This encouraging experience prompted others to administer serotonin precursors in the treatment of self-injurious behavior among children with Lesch-Nyhan syndrome.

Of seven studies published describing open-trial treatment with 5-hydroxytryptophan (68–75), two indicated improvement. The emergence of self-injurious behavior may have been prevented in another child who was treated prophylactically at an early age. Despite the indication that some modification of self-injurious behavior may occur, treatments directed at increasing serotonin availability in the CNS have not been shown reliably to diminish self-injurious behavior. In addition, self-injurious behavior may be heterogeneous, and inferences based on experience with Lesch-Nyhan syndrome may not be generalizable to other groups of patients. Regional changes in neurotransmitter function have been documented among these children compared with unimpaired children (60), further limiting extrapolation to other populations with self-injurious behavior.

Another basis for consideration of a role for the serotonergic system in self-injurious behavior is the similarity of some of its features to those of obsessive-compulsive disorder, a syndrome that has been associated with alterations of serotonergic function (76). Common to both disorders are intrusive and irresistible urges to commit an act that the individual may perceive as senseless, mounting tension associated with attempts to resist the behavior, and relief from anxiety following commission of the act. These phenomenological similarities prompt comparison between the two conditions.

Evidence for altered serotonergic function in patients with obsessive-compulsive disorder is derived from the efficacy of treatment with serotonin reuptake inhibitors (76, 77) as well as from studies of CSF concentrations of the serotonin metabolite 5-hydroxyindoleacetic acid (5-HIAA) (76). In addition, Hollander et al. (78) administered m-chlorophenylpiperazine, a

serotonin receptor agonist, to eight patients with obsessive-compulsive disorder. Six demonstrated a significant exacerbation of symptoms.

Several authors (31, 79) have reported that symptoms of self-injurious behavior in patients with coexisting obsessive-compulsive disorder responded to treatment with serotonin-reuptake inhibitors. Trichotillomania (hair-pulling) and nail-biting may represent variant forms of self-injurious behavior. In pilot trials (80, 81) these conditions have been reported to respond to fluoxetine and clomipramine. Patel et al. (82) described successful treatment of self-injurious behavior with trazodone in a patient with recurrent major depression. The medication was stopped and restarted several times for clinical reasons. Self-injurious behavior was alleviated each time medication was instituted and returned on each discontinuation. There was no concurrent improvement in depression.

Using neuroendocrine challenge tests as measures of serotonergic activity, Coccaro et al. (83, 84) studied patients with various personality disorders and observed that the *DSM-III* borderline personality disorder item "self-damaging acts" was associated with the greatest variance from control subjects (84).

5-HIAA is the major metabolite of serotonin, and its concentration in the CSF has been demonstrated to be a reliable index of serotonin concentration in the brain (85). Lopez-Ibor et al. (86) measured CSF 5-HIAA and rated the presence of "self-injuries that do not constitute a vital threat" in 21 patients with major depression. Five of the 21 patients exhibited self-aggressive behaviors. These five patients had significantly lower CSF 5-HIAA concentrations than the remaining 16 patients.

Investigations of the significance of serotonergic activity in self-injury were prompted by observations of serotonergically mediated effects on aggression in laboratory animals. In 1967, Valzelli (87) observed that various monoamine oxidase inhibitors (MAOIs), such as pargyline, increase brain serotonin more slowly in aggressive rats than in normal rats, suggesting some alteration of serotonergic turnover. He also demonstrated that administration of other serotonergic agents can induce aggressive behavior in laboratory animals. Shock-induced fighting can be potentiated by pretreatment with 5,7-dihydroxytryptamine, which depletes serotonin (88). P-Chlorophenylalanine, an inhibitor of serotonin synthesis, increases aggressive (89) and filicidal (90) behavior in rats. Mouse-killing (muricidal) behavior in rats may be induced by electrolytic (91) or neurochemical (92) lesions of serotonergic nuclei. Aggressive behavior that follows mechanical lesions of the olfactory bulb may be reversed by subsequent treatment with 5-hydroxytryptophan (89). Muricidal behavior in isolated rats was inhibited by administration of L-tryptophan, a precursor of 5-hydroxytryptophan (93).

Manipulations of other neurotransmitter systems, however, such as dopaminergic (94) and adrenergic (88) systems, have also demonstrated modulatory ef-

fects on aggression in rats. In addition, there are various forms of animal aggression that may have distinct neurochemical correlates. Further complicating extrapolation, different species may vary in response to neurochemical manipulations (95). Nevertheless, these findings provided the basis for initial speculation that self-injurious behavior may be associated with altered serotonergic function.

Although neurochemical examinations of self-injurious behavior have focused on dopamine, opiate, and serotonin systems, Kopin (96) suggested that the diazepam-binding site may be implicated. His speculation was based on the observation that caffeine, a methylpurine derivative that can elicit self-injurious behavior in laboratory animals, inhibits the binding of diazepam to its receptors. The accumulation of oxypurines in the brains of children with Lesch-Nyhan syndrome lends circumstantial support to this suggestion.

## TREATMENT

### *Pharmacological*

The scientific literature on the benefits of pharmacological agents in the treatment of self-injurious behavior is made up mainly of studies of mentally retarded persons. Several extensive reviews of this literature have been published (3, 97–100), and it will not be detailed here. Agents that have been examined include neuroleptics, lithium, carbamazepine, minor tranquilizers, propranolol, baclofen, stimulants, and antidepressants.

The reports are beset with a number of problems. Their methods differed greatly. No standard and/or reliable scale of self-injurious behavior has been developed. The need to intervene to stop self-injury may hide partial benefits. Patients with mental retardation of disparate causes were grouped together in some studies, and in some reports no distinction was made between self- and outward-directed aggression. Nonspecific sedating effects (as with neuroleptics and benzodiazepines) or the presence of undiagnosed mood disorders (which may respond to lithium and carbamazepine) complicate the interpretation of beneficial effects. The frequent presence of seizure disorders or nonspecific EEG abnormalities in this population further obscures the putative benefits of carbamazepine. Although neuroleptics are extensively used in attempts to control self-injurious behavior, it is not clear that there is sufficient benefit to justify the exposure to the morbid side effects of these drugs.

Despite the tentative nature of the available data, considerable support is emerging for the use of lithium and carbamazepine with mentally retarded patients who injure themselves. Lapierre and Reesal (99) urged caution in the use of lithium, noting that organic brain pathology in these patients may predispose them to toxic side effects. The use of serotonergic agents has

already been reviewed here. None of these approaches has yet yielded persuasive evidence of general efficacy.

There are no systematic treatment studies of self-injurious behavior in other self-injuring populations (psychotic patients, prisoners, and patients with character disorders). Among psychotic patients, whose self-harm tends to be episodic and unpredictable, usual modes of treatment for the overall illness—as well as measures taken to prevent imminent self-harm—would seem to be prudent.

Studies of pharmacological treatment for patients with character disorders may offer some guidelines for treatment of self-injurious behavior. Liebowitz (101) emphasized the interpersonal losses that often appear to precede bouts of self-injurious behavior among such individuals. He and Klein (102) compared this phenomenon to the “rejection sensitivity” noted in patients with the “hysteroid dysphoric” form of atypical depression. Liebowitz et al. (103) stated that treatment of depression with MAOI antidepressants among such individuals may be superior to treatment with tricyclic antidepressants. Cowdry and Gardner’s study of the treatment of patients with borderline personality disorder (104) supports the notion that the MAOI tranylcypromine is specifically useful for the rejection sensitivity of these patients. Extrapolating from this experience, Liebowitz (101) suggested consideration of MAOI medications for treatment of self-injuring patients.

Cowdry and Gardner (104–106) compared the benefits of tranylcypromine, alprazolam, carbamazepine, trifluoperazine, and placebo in patients with borderline personality disorder. Their findings in relation to tranylcypromine and rejection sensitivity (104) have already been noted. They also examined the effects of these medications on episodes of impulse dyscontrol (including self-injuring behavior). Although the neuroleptic and the MAOI showed trends toward fewer episodes of such behavior, only treatment with carbamazepine demonstrated a significant decrease in the number of such episodes. Alprazolam trials resulted in a significantly greater rate of severe dyscontrol than did placebo trials.

As already noted in this paper, self-injurious behavior and obsessive-compulsive disorder may share important clinical features. The successful introduction of serotonin reuptake blockers for the treatment of obsessive-compulsive disorder may indicate that trials of such medications for self-injurious behavior are warranted.

### *Behavioral*

A large body of literature has examined the environmental contingencies in which self-injurious behavior occurs among mentally retarded persons. Many attempts have been made using a variety of conditioning techniques to diminish self-injurious behavior. As summarized by Carr and Durand (107), “factors responsible for the maintenance of behavior problems fall



into two broad classes: escape behavior, controlled by negative reinforcement processes, and attention-seeking behavior, controlled by positive reinforcement processes." An example of the former may occur when classroom demands are experienced as aversive. Self-injuring behavior would be likely to result in removal from the demand situation. In an example of the latter, verbally impaired children may find that they can elicit adult attention by injuring themselves. This observation has resulted in attempts to reduce self-injurious behavior by teaching communication skills (107). Durand and Crimmins (108) reported on the use of an instrument designed to identify the variables that maintain self-injurious behavior.

Other behavioral techniques that have been used include extinction, sensory extinction, punishment, alternative-sensory activities, timeouts, and overcorrection (109). Some of the methodological problems that have been discussed in regard to pharmacological trials apply to these trials as well, particularly the need to intervene to reduce injury and the lack of standard, reliable rating instruments. Behavioral treatment methods are labor-intensive and, despite their apparent potential for diminishing self-injurious behavior, may be extremely difficult to implement on a large scale. Nevertheless, some behavioral interventions appear to be successful, and they present none of the risks associated with pharmacological approaches.

#### *Milieu Therapy*

Inpatient units with treatment environments dedicated to the identification and containment of acting-out behaviors have been advocated for the treatment of patients with borderline personality disorder (110). In such environments, patients' attempts at "splitting" staff and uses of other primitive forms of psychological defense are readily identifiable and made accessible to interpretation. Self-injuring patients with borderline personality disorder may benefit from such treatment. Similarly, Grunebaum and Klerman (24) supported an inpatient treatment strategy based on ego psychology with a strong emphasis on understanding the "interpersonal dynamics of the ward social structure." It may be particularly important in such an environment carefully to guard against surreptitious self-harm. The milieu's challenge to the patient's defensive structure may motivate the use of defenses that may be kept "invisible" from staff.

Another approach is taken in an inpatient program directed to the treatment of self-injurious behavior (111). Patients are admitted for 30 days; on admission they sign a no-harm contract in which they commit themselves to refrain from self-injury and to approach a staff member should the inclination arise. A single episode may result in discharge from the program. During their hospital stay, patients are discouraged from focusing on self-injurious behavior and are urged to examine other stresses in their life, such as deteriorating marriages or histories of incestuous assault.

Since these approaches depend on labor-intensive and costly inpatient treatment, demonstration of efficacy is important. Both approaches are grounded in clinical experience, but no systematically obtained data are available concerning either short-term or long-term benefits to patients in the reduction of self-injurious behavior.

#### *Self-Help Groups*

Several self-help groups exist in different U.S. cities for patients with self-injurious behavior. Some have modeled themselves after the 12-step program of Alcoholics Anonymous. The courses of individuals who participate in these programs have not yet been examined.

### DISCUSSION

#### *Confinement, Serotonin, and Isolation*

Confinement may be a specific provocateur of self-injurious behavior for vulnerable persons. The contexts in which self-injurious behavior occurs include prisons (10, 12), corrective institutions for adolescent offenders (21), inpatient facilities for the mentally retarded (1-3), and inpatient adolescent psychiatric units (112). In each of these contexts, some individuals are described who have no history of self-injurious behavior until admission.

If certain personality disorders predispose an individual to self-injurious behavior, the apparent prevalence of self-injurious behavior in prisons may be a consequence of the presence of such pathology among inmates. Within this high-risk population, certain characteristics may be associated with greater vulnerability to self-injurious behavior. Virkkunen (16) found a higher rate of impulsivity and antisocial traits among self-injuring prisoners than among non-self-injuring prisoners.

The observation that imprisonment may elicit self-injurious behavior in humans prompts comparison with self-injury among animals. Jones (29) observed that "practically all known reports of self-injury in macaques [a primate] have been recorded when the animal is physically restricted and usually when isolated." Although comparisons between human behavior and animal behavior should be made cautiously, the similarity in potentiating conditions for self-injury is of interest—and may even reflect an ethological basis for the "aloneness" that seems to precipitate self-injurious behavior among individuals with borderline personality.

Isolation has long been known to increase aggression in rodents (87). Valzelli and Bernasconi (113) studied seven strains of mice who had been housed in either grouped or isolated conditions. Severity of isolation-induced aggression was scored and brain 5-HIAA concentrations were subsequently measured. Those strains in which brain 5-HIAA differed between



isolated and nonisolated conditions also demonstrated the highest aggression scores. This study suggests that isolation may be associated with decrements in serotonin turnover in certain strains of mice and that this decrement may be associated with isolation-induced aggression. It is tempting to consider that conditions which are apparently associated with increased self-injurious behavior in humans (such as solitary confinement and object loss) may bear similarities to the isolation of laboratory mice.

### *The Search for Biological Markers*

Recent years have seen the emergence of a symptom-based approach to the study of biological bases of psychopathology. Narrowing the focus of CSF neurochemical studies from depressive syndromes to suicidal behavior (114) revealed an association between altered serotonergic function and suicidality, an association that crosses traditional diagnostic lines. Other studies that narrowed the search for markers from syndromes to individual symptoms have yielded new findings associating impulsiveness—in particular violent impulsive behavior—with markers of altered serotonergic function (83, 115). Similarly, it is reasonable to consider that self-injurious behavior in various conditions may have a common organic component, independent of coexisting syndromal diagnoses.

This notion is of great clinical significance because it suggests the potential for independently treating individual morbid symptoms in the context of overall refractory conditions such as schizophrenia and severe depression. As we have discussed elsewhere (114), although individuals afflicted with refractory illnesses may have other symptoms, specific relief from suicidal impulses, for example, may be of great benefit. The relief of specific symptoms may be of great pragmatic value for patients who suffer from self-injurious behavior in the presence of intractable conditions, such as mental retardation and severe personality disorder.

### CONCLUSIONS

We have reviewed data suggesting that self-injurious behavior may be associated with serotonergic dysfunction. Although the evidence is not conclusive, it does prompt speculation regarding variant symptoms that appear to be related to alterations of serotonergic function. In particular, suicidal behavior (114), obsessive-compulsive disorder (76), fire-setting (115), and impulsive violence (115) have been shown to be associated with changes in various serotonergic measures. If these symptoms are, indeed, the sequelae of serotonergic dysfunction, they may be the result of varying physiological lesions. Alternatively, all or several of these symptoms may represent variant expressions of a common lesion. In addition to its theoretical significance, this question has important implications for the conduct of psychiatric research, particularly familial and

genetic research. Studies that are dependent on identifying affected individuals must be able to identify variant expressions of physiological defects.

Although the data to support such a conclusion are still inadequate, it is reasonable to speculate that a cluster of symptoms is emerging which share both altered serotonergic function and elements of impulse dyscontrol. Given the complexity of neurochemical interactions, it is likely that more than one neurotransmitter system will be ultimately implicated in these behaviors. Nevertheless, these converging observations strongly suggest the value of examining serotonergic function as it may mediate impulsiveness. The developing repertoire of techniques that are becoming available for clinical study of this system makes it a functionally useful starting point.

We have reviewed the scientific literature regarding self-injurious behavior. Two issues raised by other authors should be mentioned.

Several authors (39, 116) have observed frequent histories of childhood sexual assault among individuals with self-injurious behavior, and some have concluded that self-injurious behavior in these individuals may be the outcome of such abuse. In an unpublished survey of bulimic patients, Fallon and Winchel found that such abuse was more frequently reported among patients who injured themselves but that not all patients who injured themselves reported histories of abuse. Although the importance and grave traumatic effects of childhood sexual abuse should not be underestimated, a cause and effect relationship between abuse and self-injurious behavior should not be automatically assumed. Sexual abuse may serve to elicit symptoms in an individual already at risk, but frequent histories of such trauma may also reflect a familial predisposition to impulsive—and perhaps violent—behaviors. An interplay of both factors suggests the unfortunate possibility that those who are biologically endowed with a vulnerability to self-injurious behavior may also have a greater probability of being raised in a familial environment where the stresses that might elicit such behavior—such as childhood sexual abuse—are more likely to occur.

Another issue that has been raised has been the suggestion that a triad of symptoms (self-injury, eating disorder, and alcohol abuse) deserves a separate diagnosis in *DSM-IV* (27). In our experience, a substantial number of patients with this triad may be identified. It is not yet clear, however, that a separate designation would specify anything other than a subgroup of existing categories, such as borderline personality disorder. If an individual with self-injurious behavior does not otherwise meet criteria for borderline personality disorder or antisocial personality disorder, the *DSM-III-R* diagnosis of impulse control disorder not otherwise specified may be applied to these patients. The frequency of this proposed triad among individuals with self-injurious behavior deserves investigation.

In summary, self-injurious behavior is a poorly understood phenomenon in both its behavioral and bio-

chemical aspects. It occurs in a variety of clinical settings, and features of the behavior vary among these settings. Isolation, confinement, and interpersonal traumata may facilitate the expression of these behaviors. Mental retardation, criminal sociopathy, eating disorders, and borderline personality may be associated with self-injurious behavior. We have reviewed data suggesting that serotonergically, opiatergically, and/or dopaminergically mediated processes may be implicated in self-injurious behavior. Although no form of treatment has yet been demonstrated to be of general benefit, these data suggest that therapeutic trials with dopamine antagonists, serotonin reuptake inhibitors, and opiate antagonists may be of value.

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